CeC PoP Experiment: Commissioning Sequence, Support, Procedures, and Training Requirements

Lee Hammons

Deputy Group Leader, C-A Main Control Room

Collider-Accelerator Department

1 March 2015

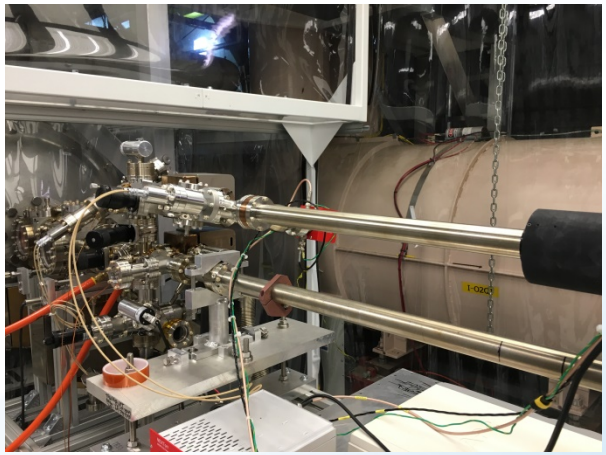
BROOKHAVEN NATIONAL LABORATORY

a passion for discovery

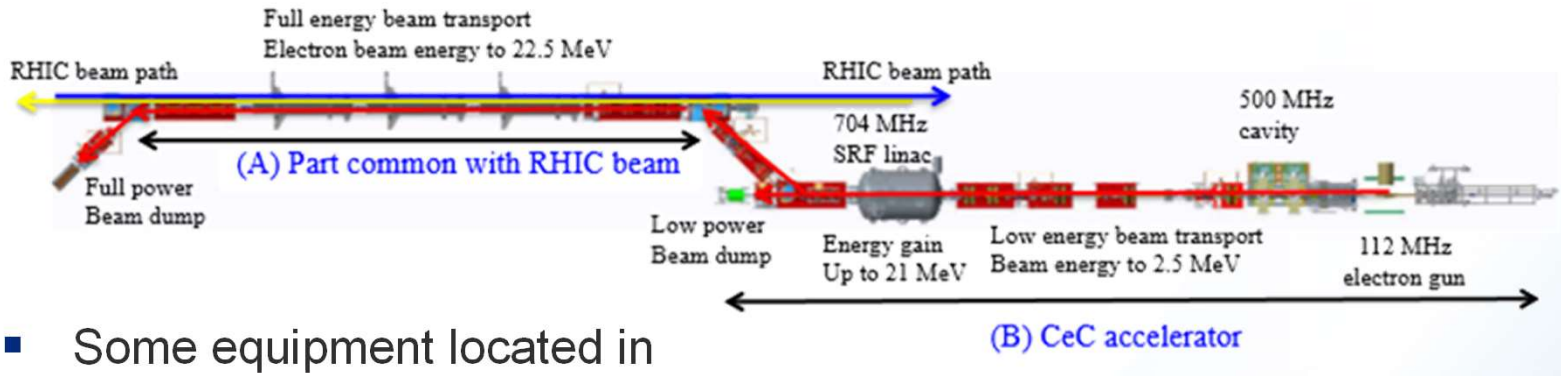
Office of Science
U.S. DEPARTMENT OF ENERGY

Overview

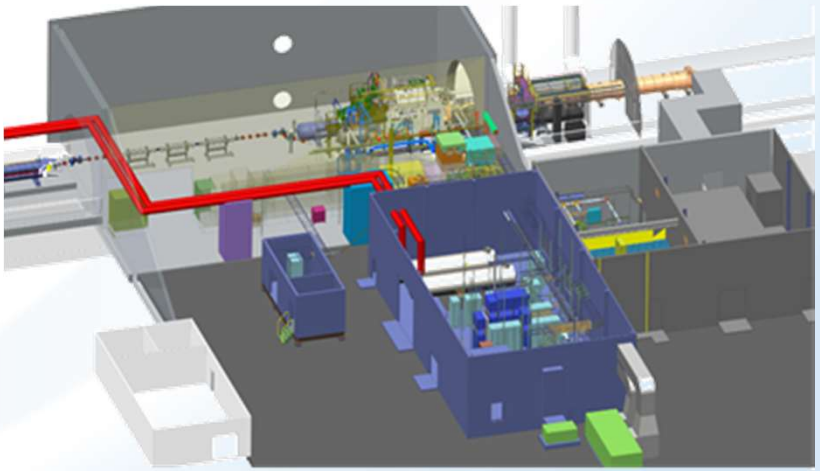
- Commissioning Plan
- Staging
- Commissioning Organization
- Training Requirements
- Procedures



The CeC PoP Experiment

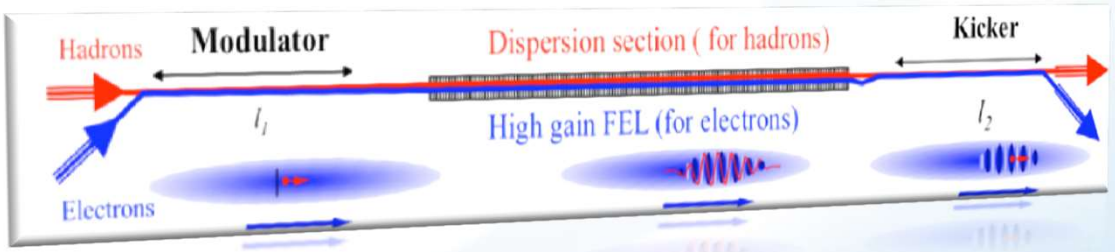


- Some equipment located in portion of service buildings (1002A and 1002B).
- Laser equipment located in new building, 1002F, outside IP.
- Control area for experiment located in Main Control Room, located in Bldg. 911.



Goals of CeC PoP Experiment

- Programmatic:
  - Successful demonstration of Coherent Electron Cooling concept.
  - Reduction of energy spread in hadron beam through introduction of electron beam.
- Operational:
  - Commission and operate the CeC PoP accelerator
  - Generate, accelerate, and transport electron beam.
    - First to low-power dump
    - Next to high-power through common RHIC beam pipe



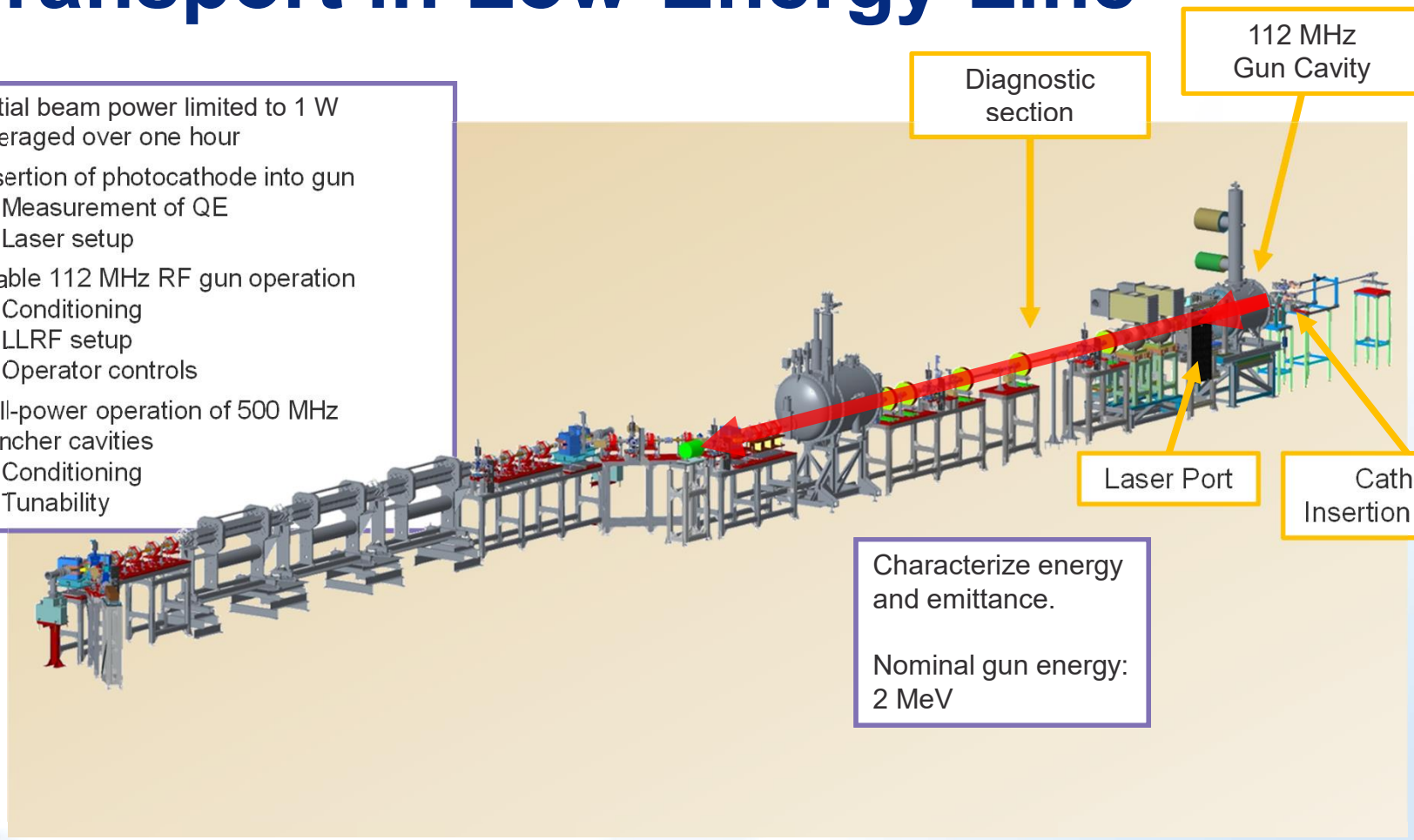
Commissioning Plan: Transport in Low-Energy Line

Initial beam power limited to 1 W averaged over one hour

Insertion of photocathode into gun
- Measurement of QE
- Laser setup

Stable 112 MHz RF gun operation
- Conditioning
- LLRF setup
- Operator controls

Full-power operation of 500 MHz buncher cavities
- Conditioning
- Tunability



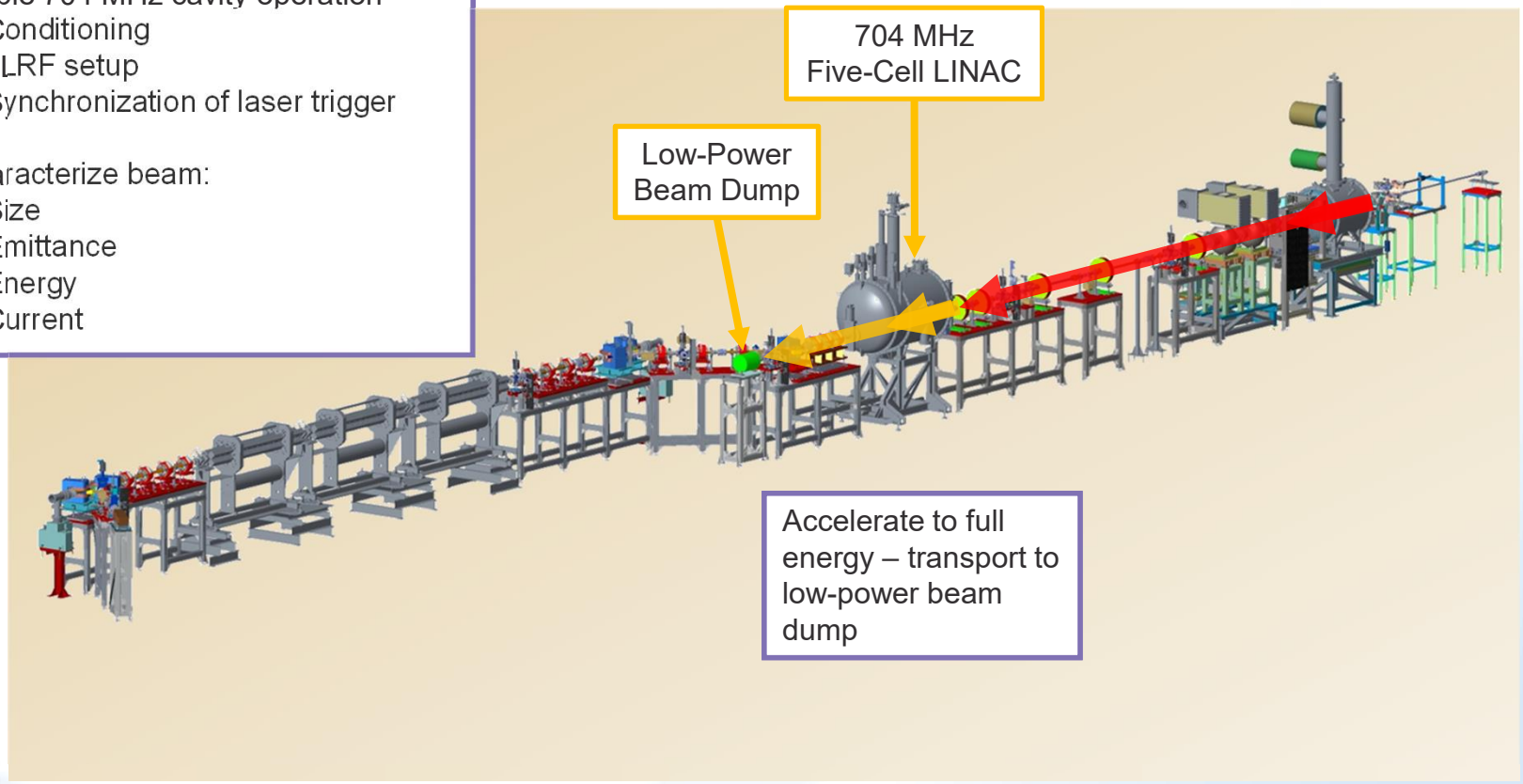
Characterize energy and emittance.

Nominal gun energy: 2 MeV

Commissioning Plan: Acceleration in 704 MHz Cavity

Stable 704 MHz cavity operation
- Conditioning
- LLRF setup
- Synchronization of laser trigger

Characterize beam:
- Size
- Emittance
- Energy
- Current

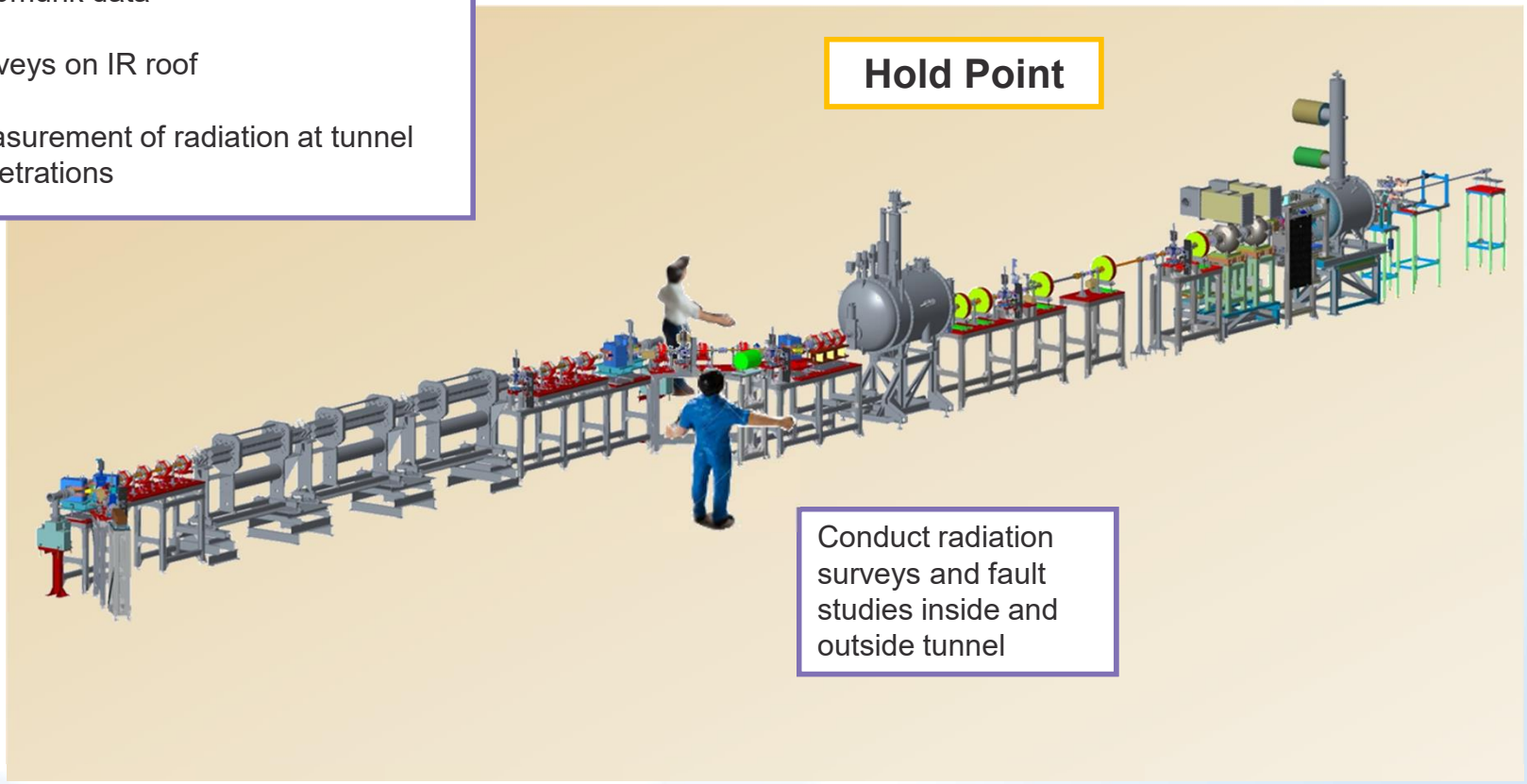


Commissioning Plan:
Hold Point, Radiation Surveys, Fault Studies

Chipmunk data

Surveys on IR roof

Measurement of radiation at tunnel penetrations



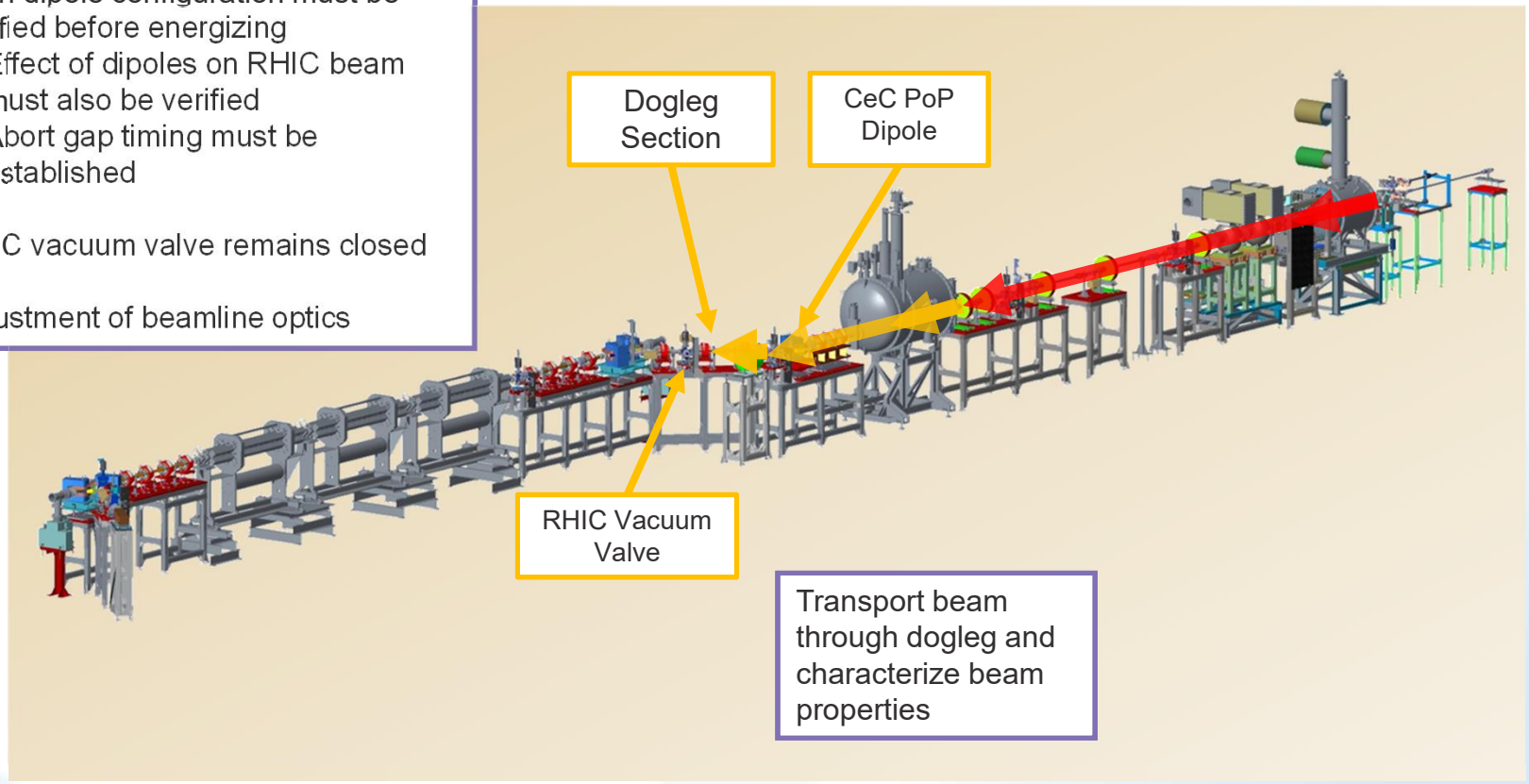
Commissioning Plan: Transport in Dogleg

Main dipole configuration must be verified before energizing

- Effect of dipoles on RHIC beam must also be verified
- Abort gap timing must be established

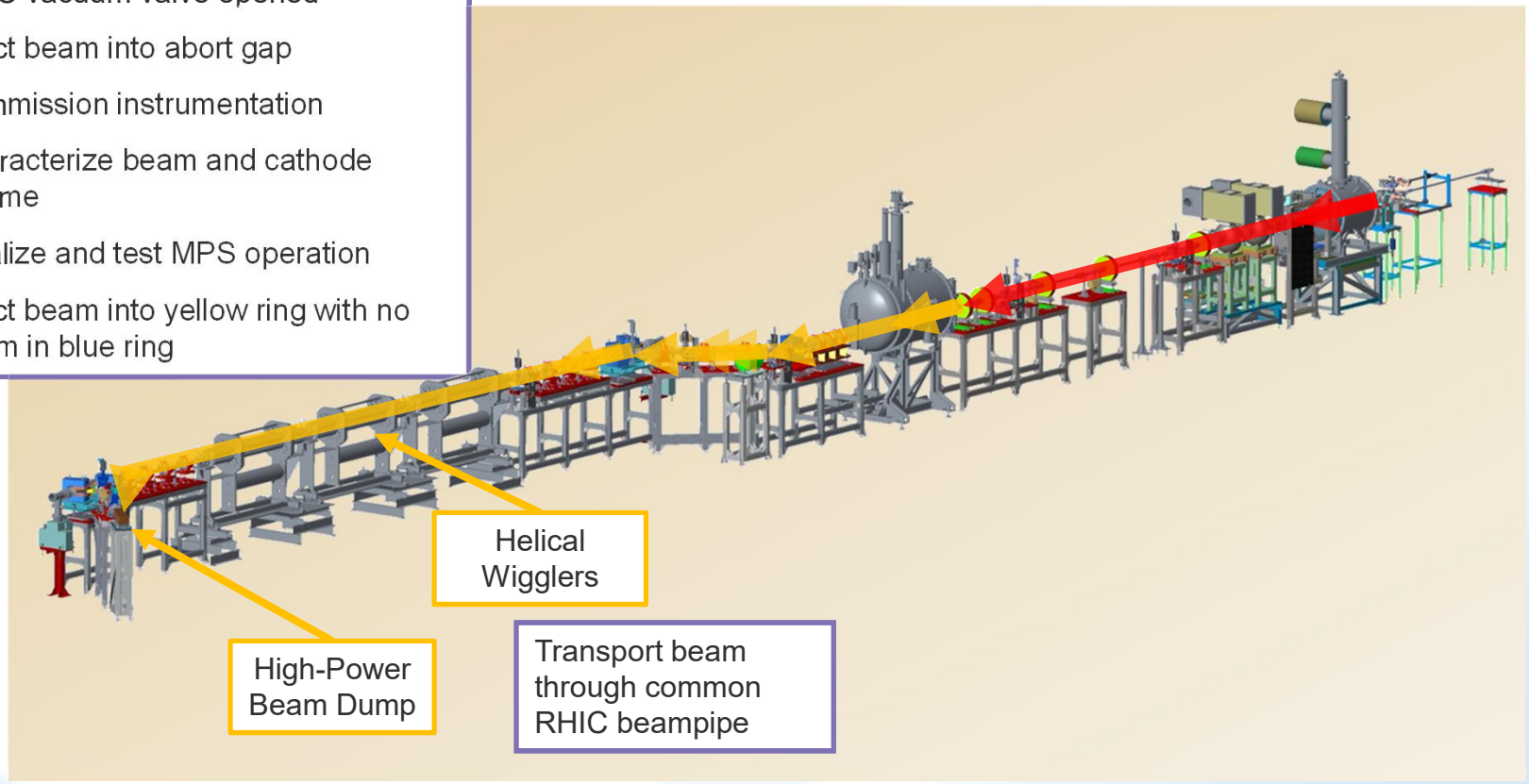
RHIC vacuum valve remains closed

Adjustment of beamline optics

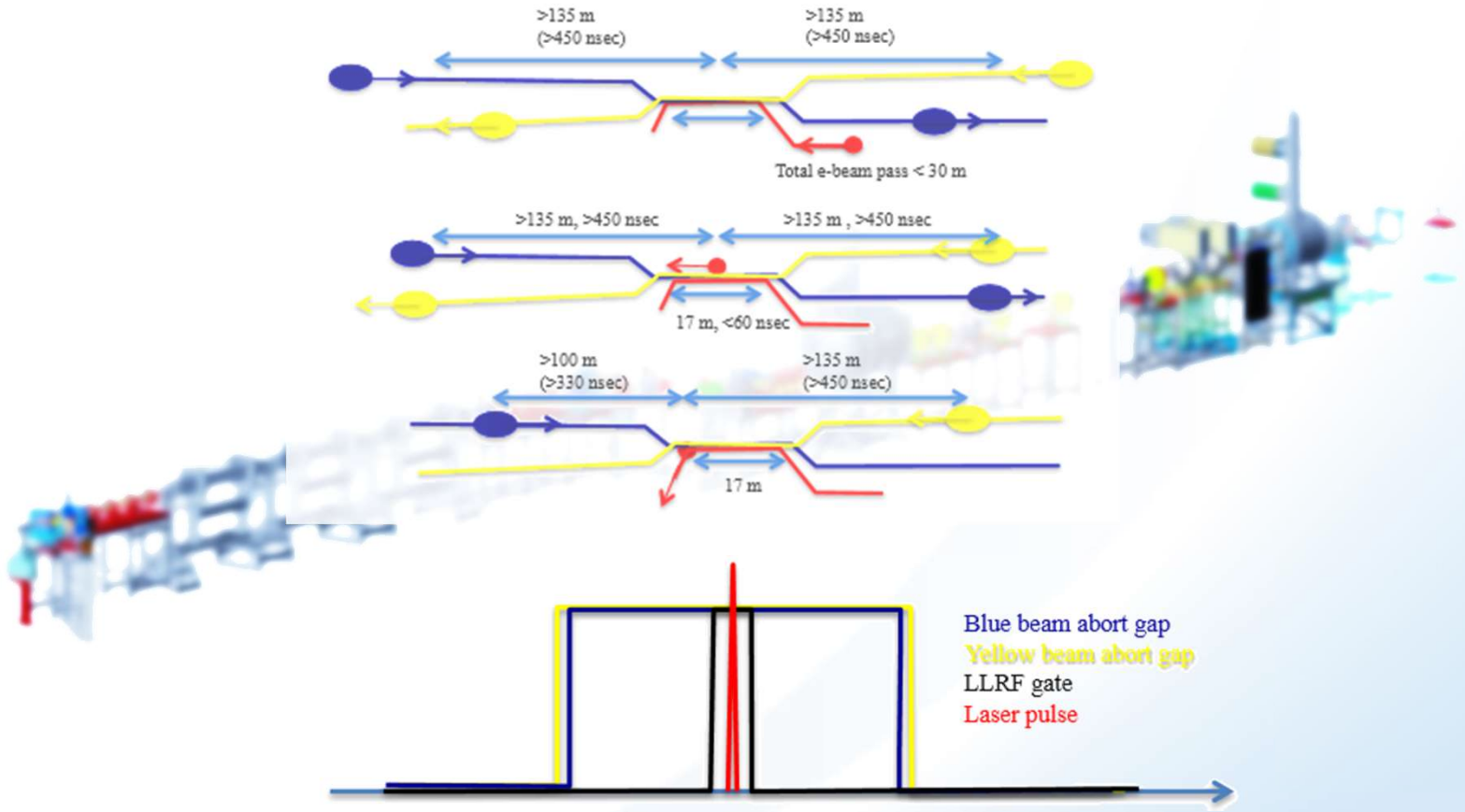


Commissioning Plan: Transport in Common Beampipe

- RHIC vacuum valve opened
- Inject beam into abort gap
- Commission instrumentation
- Characterize beam and cathode lifetime
- Finalize and test MPS operation
- Inject beam into yellow ring with no beam in blue ring



Abort Gap Timing



Commissioning Plan:
Hold Point, Radiation Surveys, Fault Studies

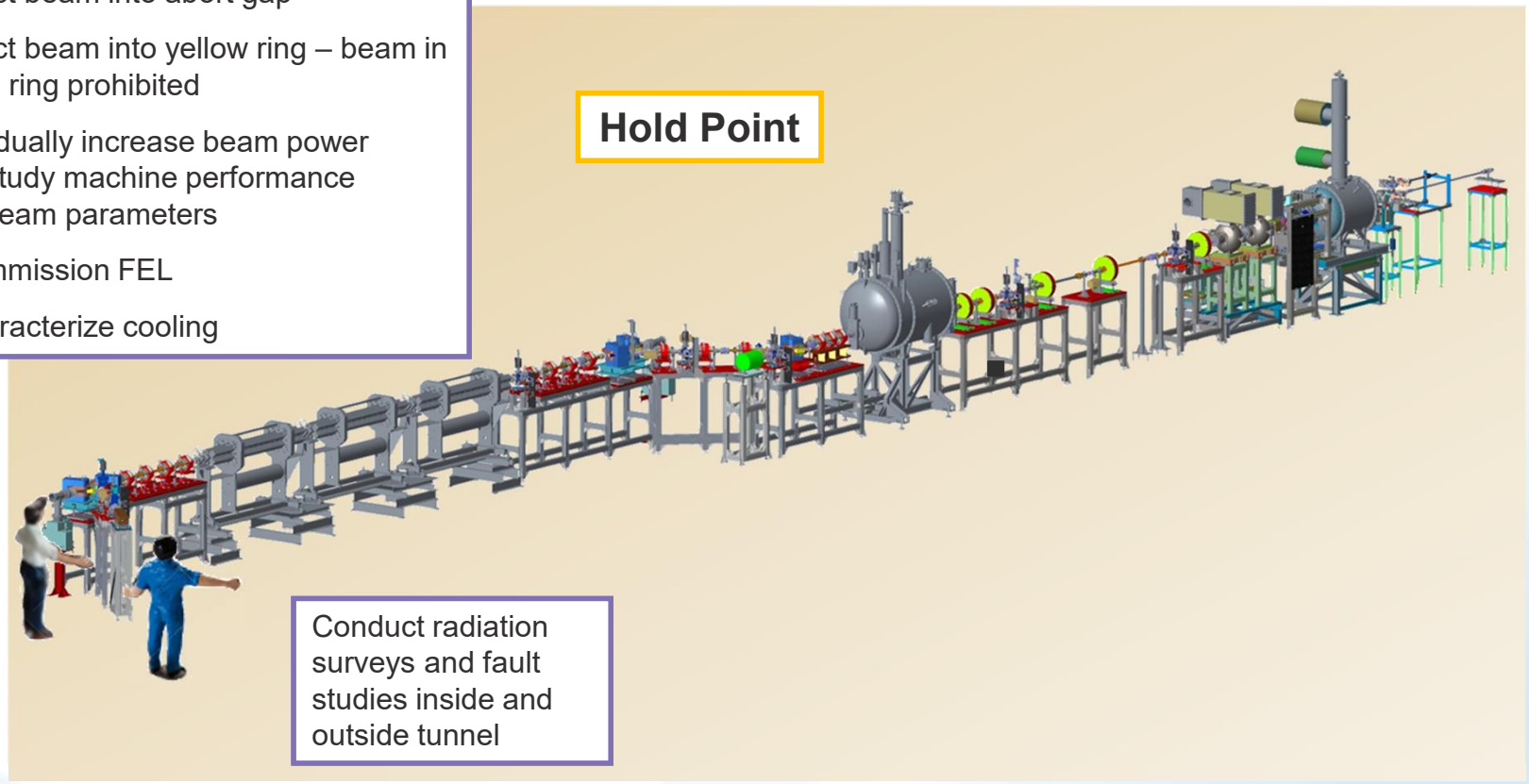
Inject beam into abort gap

Inject beam into yellow ring – beam in blue ring prohibited

Gradually increase beam power
- Study machine performance
- Beam parameters

Commission FEL

Characterize cooling



Commissioning Plan Summary

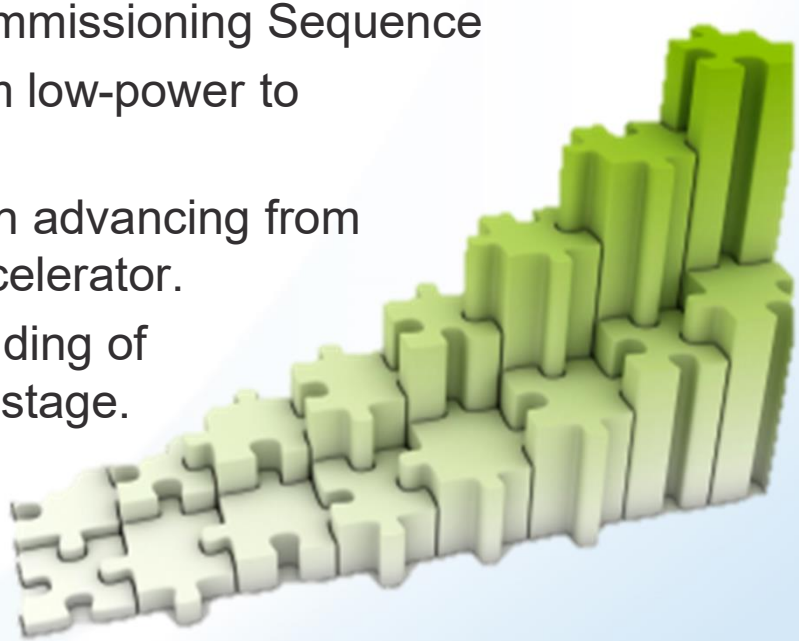
1. Establish electron beam from SRF gun cavity to diagnostic section.
   - Establish pulsing from laser to limit beam power to 1 W averaged over one hour.
2. Transport beam to 704 MHz accelerating cavity and low-power beam dump.
   - Only beam power < 1 W averaged over one hour may be transported to low-power beam dump.
3. Conduct radiation surveys and fault studies with beam to low-power dump.
4. Transport beam into dogleg.
   - RHIC valve closed.
   - Dipole magnets configured.
5. Open RHIC valve and synchronize beam with abort gap.
6. Transport beam to high-power beam dump.
7. Conduct radiation surveys and fault studies with beam to high-power dump.
8. Gradually increase beam power through system and deploy helical wigglers, continuing to conduct radiation survey and assess system performance.
9. Establish interaction mode with gold beam in yellow RHIC ring.
   - Blue beam prohibited in this mode.
10. Operate in dedicated CeC mode to demonstrate cooling of ion beam using full power electron beam (8.5 kW averaged over one hour).
11. Characterize parameters of CeC process.

Commissioning Plan Controls

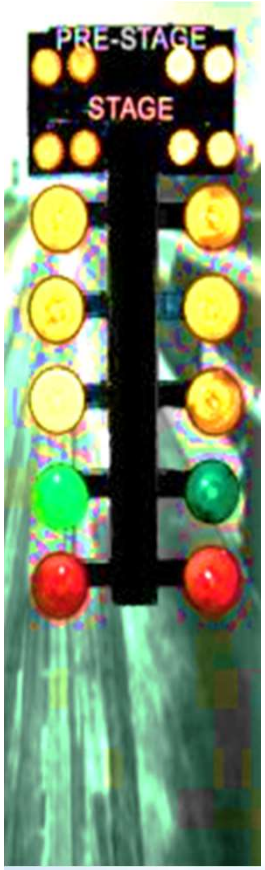
- Commissioning carried out in accord with safety-related assumptions in SAD.
- Planned activities will not violate limits set by CeC PoP ASE
  - OPM 2.5.2 – Accelerator Safety Envelope Credited Controls, Supports and Administrative Controls for RHIC
  - OPM 22.5.3 – CeC PoP Commissioning Sequence
- Fault studies carried out according to C-A procedures and with a tailored fault study plan approved by Radiation Safety Chairman
  - OPM 9.1.9 – Fault Study Procedure

Commissioning Plan Approach

- Commissioning sequence will unfold in stages governed by commissioning procedure.
  - OPM 22.5.3 – High-Power Commissioning Sequence
  - Staged, gradual approach from low-power to high-power beam operations.
  - Staged, geographical approach advancing from beginning to the end of the accelerator.
  - Assures control and understanding of machine performance at each stage.
  - Allows commissioning activities to be completed in systematic manner throughout.
  - Radiation surveys conducted throughout program evolution.



Beam Power



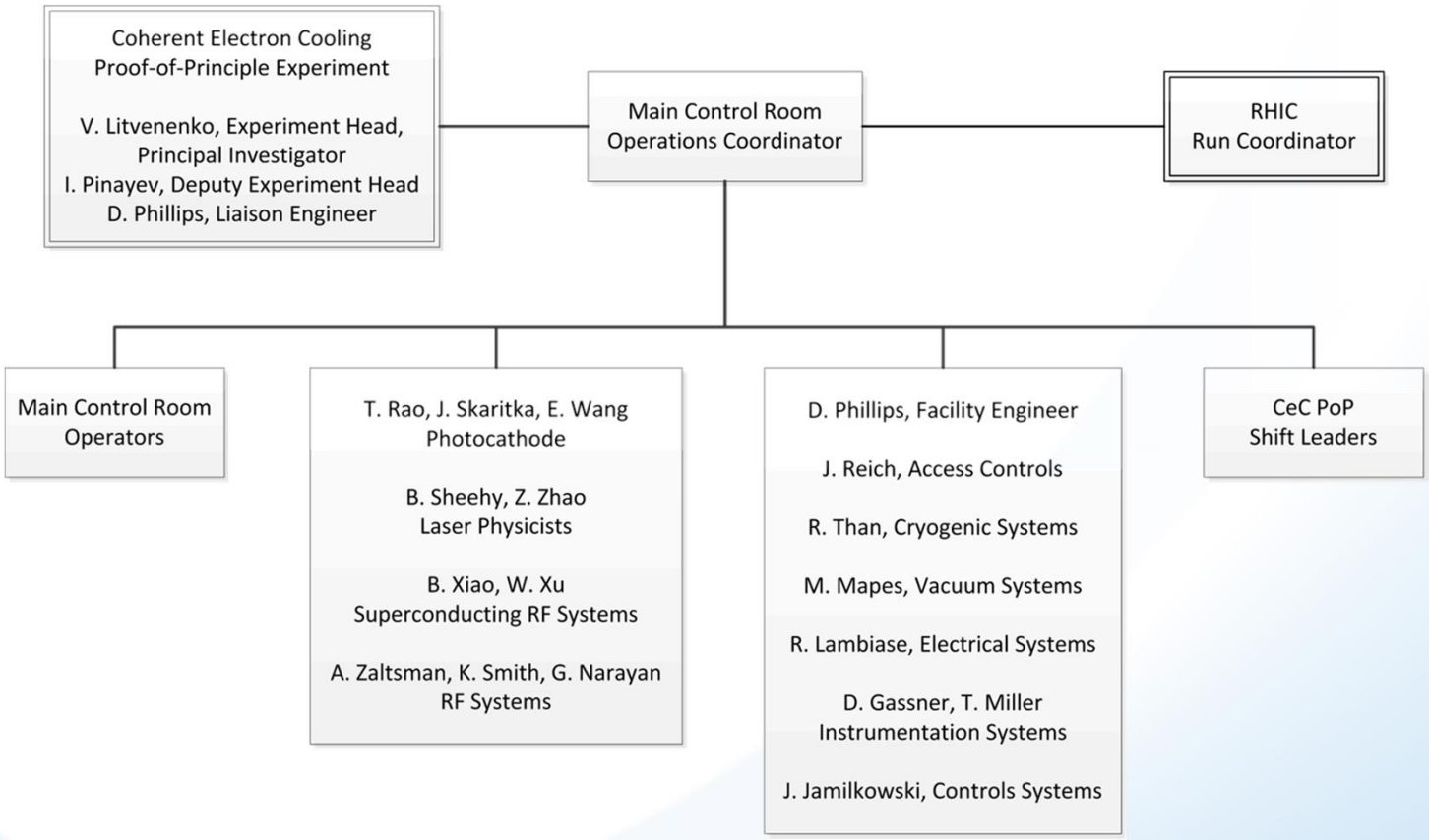
- Beam power will be increased in stages

- **< 1 W avg. over one hour**
  - Low-power stage
  - Beam to low- and high-power beam dump
  - Commissioning of equipment
  - Fault studies and radiation surveys
- **< 10 W avg. over one hour**
  - Beam to high-power beam dump
  - Goal to perform fault studies that create measurable levels of secondary radiation
  - Conduct radiation surveys
- **< 100 W avg. over one hour**
  - Continue commissioning
  - No further fault studies planned at this stage or beyond to prevent equipment damage
  - Extrapolate radiation measurements
  - Conduct radiation surveys
- **< 1 kW avg. over one hour**
  - Continue commission activities
  - Conduct radiation surveys
- **≤ 8.5 kW avg. over one hour**
  - End of commissioning – transition to operations
  - Conduct radiation surveys
  - Maximum beam power level

Commissioning Personnel

- All beam operations will be based in MCR.
- MCR personnel will be involved in testing and commissioning efforts including OCs and operators.
- C-A Conduct of Operations will govern the commissioning and operations effort.
- Conduct of Operations program in C-A is well-established:
  - New procedures have been added.
  - Operations staff is very familiar with operation of new and experimental facilities.

CeC PoP Commissioning Organization



OPM 22.2.1 – Experiment Organization and Administration Experiment Roles

- The CeC PoP Shift Leader
  - Responsible for administration and coordination of experiment:
    - ***During RHIC operation, shift leader will inform MCR OC about plans to operate experiment.***
    - ***During maintenance periods, shift leader will coordinate maintenance activities with the Maintenance Coordinator and the CeC PoP Liaison Engineer.***
  - Responsible for communication with operating groups about plans for operational activities per OPM 2.11 including:
    - MCR Operations Coordinator
    - MCR Operators
    - Accelerator subsystem groups

Experiment Roles

- The CeC PoP Liaison Engineer
  - Responsible for coordination of work planning and maintenance.
    - Coordinates maintenance with Shift Leader and Maintenance Coordinator.
  - Responsible for management of configuration-controlled elements of experiment such as magnetic systems.

Experiment Roles

- MCR Operations Coordinator
  - Assures safe operation of the experiment.
  - Assures safe operation of the RHIC complex.
  - Duties outlined in OPM 2.1.
- MCR Operators
  - Responsible for safe operation of experiment and the RHIC complex.
  - Responsible for enforcing OPM procedures during CeC PoP commissioning and operations.

Additional Roles

- Subsystems support specialists:
  - Laser operator
  - Photocathode physicists
  - Superconducting RF physicists
  - RF system engineering
  - Cryogenics engineering
  - Vacuum engineering
  - Access control system engineering
  - Beam diagnostics and instrumentation engineering
  - Facility engineering

Training and Qualification Requirements

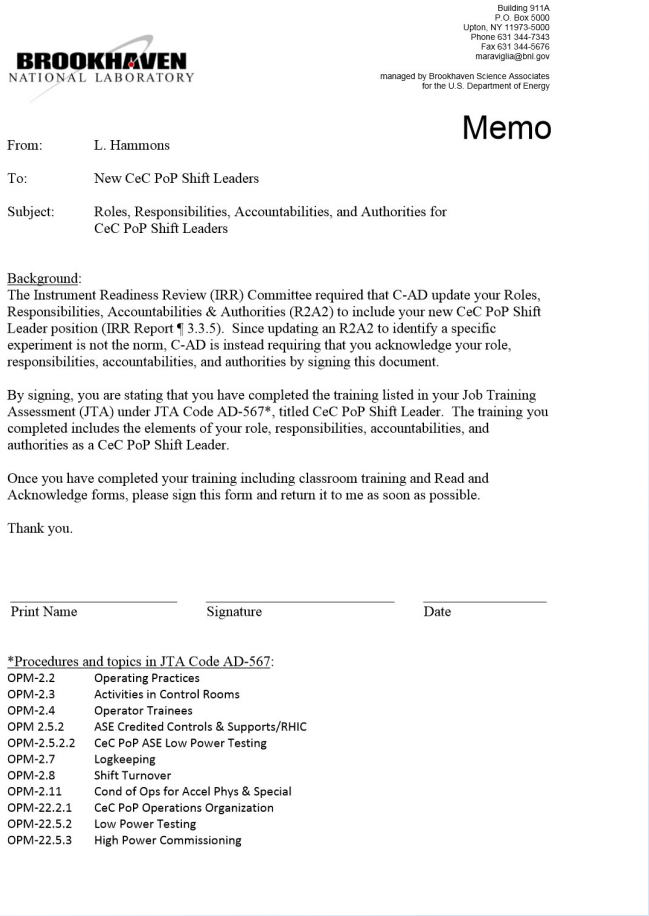
- New requirements added to existing requirements to fulfill roles of experimental organization.
  - MCR operations staff already possess extensive training requirements that are documented in BTMS.
  - Subsystem engineers and technicians also possess extensive training specific to subsystems documented in BTMS.
- Shift Leader, Liaison Engineer, MCR Operations Coordinators, and MCR Operators trained in OPM 22.2.1.
  - CeC PoP Operations Organization and Administration
- Subsystem specialists shall be trained in technical procedures specific to CeC PoP.

Training Requirements for CeC PoP Shift Leaders

- JTA AD-567: CeC PoP Shift Leader
  - 22.2.1 - CeC PoP Operations Organization
  - 22.5.2 – CeC PoP Low-Power Testing Sequence
  - 22.5.3 – CeC PoP Commissioning Sequence
  - 2.5.2 – Accelerator Safety Envelope Credited Controls, Supports, and Administrative Controls for RHIC
  - 2.5.2.2 – Testing Safety Envelope Procedure for Coherent Electron Cooler (CeC) Testing in RHIC
  - 2.2 – Operating Practices
  - 2.3 – Activities in Control Rooms
  - 2.4 – Operator Trainees
  - 2.7 – Logkeeping
  - 2.8 – Shift Turnover
  - 2.11 - Conduct of Operations for Accelerator Physicists and System Specialists
- Training requirements documented in BTMS

R2A2 Requirements for Shift Leaders

- Addressed in JTA AD-567 training:
  - Roles
  - Responsibilities
  - Accountabilities
  - Authorities
- All shift leaders sign memo indicating their understanding of R2A2 requirements after completion of training.
- Placed in C-A training record.



BROOKHAVEN NATIONAL LABORATORY

Building 911A
P.O. Box 5000
Upton, NY 11973-5000
Phone 631 344-7343
Fax 631 344-5676
maravigliia@bnl.gov

managed by Brookhaven Science Associates
for the U.S. Department of Energy

Memo

From: L. Hammons

To: New CeC PoP Shift Leaders

Subject: Roles, Responsibilities, Accountabilities, and Authorities for CeC PoP Shift Leaders

Background:
The Instrument Readiness Review (IRR) Committee required that C-AD update your Roles, Responsibilities, Accountabilities & Authorities (R2A2) to include your new CeC PoP Shift Leader position (IRR Report ¶ 3.3.5). Since updating an R2A2 to identify a specific experiment is not the norm, C-AD is instead requiring that you acknowledge your role, responsibilities, accountabilities, and authorities by signing this document.

By signing, you are stating that you have completed the training listed in your Job Training Assessment (JTA) under JTA Code AD-567*, titled CeC PoP Shift Leader. The training you completed includes the elements of your role, responsibilities, accountabilities, and authorities as a CeC PoP Shift Leader.

Once you have completed your training including classroom training and Read and Acknowledge forms, please sign this form and return it to me as soon as possible.

Thank you.

Print Name _____ Signature _____ Date _____

*Procedures and topics in JTA Code AD-567:

OPM-2.2	Operating Practices
OPM-2.3	Activities in Control Rooms
OPM-2.4	Operator Trainees
OPM 2.5.2	ASE Credited Controls & Supports/RHIC
OPM-2.5.2.2	CeC PoP ASE Low Power Testing
OPM-2.7	Logkeeping
OPM-2.8	Shift Turnover
OPM-2.11	Cond of Ops for Accel Phys & Special
OPM-22.2.1	CeC PoP Operations Organization
OPM-22.5.2	Low Power Testing
OPM-22.5.3	High Power Commissioning

Trained CeC PoP Shift Leaders

- Yue Hao
- Yichao Jing
- Dmitry Kayran
- Vladimir Litvinenko
- Geetha Narayan
- Igor Pinayev
- Kevin Smith
- Erdong Wang
- Gang Wang
- Binping Xiao
- Wencan Xu

- All shift leaders have completed training.
  - Completion records still being updated in BTMS.
  - Only trained and qualified personnel will serve as shift leaders.
- Provides sufficient staff for at least one shift leader per shift throughout the week.

Training Requirements for MCR Operators and Coordinators

- JTA AD-565: CeC PoP MCR Operations Training
  - 2.5.2 - Accelerator Safety Envelope Credited Controls, Supports, and Administrative Controls for RHIC
  - 2.5.2.2 - Testing Safety Envelope Procedure for Coherent Electron Cooling (CeC) Testing in RHIC
  - 4.1 - Access to Primary Areas
  - 4.44 - Operations of PASS
  - 4.56.ai - RHIC Zone 2Z1 Sweep Checklist
  - 22.2.1 - CeC PoP Operations Organization
- Training documented in BTMS.
- All required MCR operators have completed training.
  - Sweep training completed as availability of RHIC zone permits.
  - Sufficient number of operators and coordinators have been trained to commence operations.
  - Only trained operators will be permitted to participate in commissioning activities.

Procedure Requirements for CeC PoP Experiment

Chapter 2	ACCELERATOR SAFETY ENVELOPE PROCEDURES
2.5.2	Accelerator Safety Envelope Credited Controls and Supports for RHIC
2.5.2.2	Testing Safety Envelope Procedure for Coherent Electron Cooler (CeC) Testing at Low Power (≤ 1 W) in RHIC
Chapter 3	**EMERGENCY PROCEDURES**
3.0.a	Emergency Call-Down List
Chapter 4	**ACCESS CONTROLS FOR CEC POP**
4.1	Access to Primary Enclosure
4.44	Operation of PASS
4.56.ai	RHIC Zone 2Z1 Sweep Checklist
4.120…	2 O'Clock (PEER 11) Functional Testing
Chapter 7	**CRYOGENIC SYSTEM OPERATIONS**
7.1.81	CeC Cryogenic System Operation

Chapter 22	COHERENT ELECTRON COOLING PROOF-OF-PRINCIPLE EXPERIMENT
22.2	**OPERATIONS ORGANIZATION AND ADMINISTRATION**
22.2.1	CeC PoP Operations Organization
22.5	**CEC POP OPERATIONS**
22.5.1	Procedure for CeC Cathode Insertion
22.5.2	Low-Power Testing Sequence
22.5.3	High-Power Commissioning Sequence
22.5.5	Procedure for Configuration Control of Critical Dipole Magnets
22.5.5.a	CeC PoP Magnetic Configuration Checklist
22.8	**SUBSYSTEMS: RF, VACUUM, WATER, LASER & CONTROLS**
22.8.1	**RF**
22.8.1.2	Turning on the 112 MHz RF Amplifier
22.8.1.3	Turning on the 704 MHz RF Amplifier
22.8.4	**LASER**
22.8.4.1	CeC PoP Laser System Operation
22.8.5	**CONTROLS**
22.8.5.1	Machine Protection System Test Procedure
Chapter 23	**LASER STANDARD OPERATING PROCEDURES**
23.7	Laser Standard Operating Procedure

Communication Within Experiment

- Weekly meetings
- Experiment e-log
- Shift turnover briefings
- Subsystem training opportunities for shift leaders and MCR operations staff
- Sharepoint site

Summary

- Goal of program is to operate electron accelerator to demonstrate longitudinal cooling.
- Commissioning will occur in stages:
  - Low-power progressing to high-power.
  - Defined hold points for radiation surveys and fault studies.
  - Commissioning will be conducted in accordance with Accelerator Safety Envelope.
- Commissioning will be conducted from Main Control Room.
  - Control room operators are well-trained in C-A Conduct of Operations.
  - Organization of experiment has been finalized and experimentalists and operations staff have been trained in appropriate procedures.
    - CeC Shift Leaders have been trained in the C-A Conduct of Operations program.
    - Only trained and qualified personnel will participate in experimental program.
- Additional procedures have been developed and all have been reviewed and approved.
- All training documented in BTMS.